CLAIM LISTING

Please amend claims 1, 6, 16, and 25 as follows:

1.   (Currently amended) A method of snapshot operation for a data storage system with a first host that communicates with a cache memory, a source Virtual Logical Unit Number (VLUN) containing source data and a target VLUN, preserving first snapshot data of the source data at an instant in time and second snapshot data of the source data at a later instant in time, wherein the first and second snapshots persist concurrently, comprising:

generating first metadata to locate the first snapshot data and to indicate when a data element of the first snapshot data is in the target VLUN; and

generating second metadata to locate the second snapshot data and to indicate when a data element of the second snapshot data is in the target VLUN; wherein the first and second metadata locate an original data element of the first snapshot data and of the second snapshot data at the same address in of the target VLUN.

2.   (Previously presented) The method of claim 1, wherein generating the first metadata includes generating a first log file pointer to locate the original data element in the target VLUN.

3.   (Previously presented) The method of claim 2, wherein generating the first metadata includes changing a first bitmap to indicate the original data element has migrated to the target VLUN.

4.   (Previously presented) The method of claim 1, wherein generating the second metadata includes generating a second log file pointer to locate the original data element in the target VLUN.

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1   5.   (Previously presented) The method of claim 4, wherein generating the

2   second metadata includes changing a second bitmap to indicate has migrated to the

3   target VLUN.

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5   6.   (Curently amended) A snapshot system for a data storage system

6   including a first host that communicates with a cache memory, a source Virtual Logical

7   Unit Number (VLUN), a target VLUN, and metadata, comprising:

8   a source VLUN for active data;

9   a target VLUN to store migrated snapshot data;

10   first metadata to indicate when and to locate where the first snapshot of the

11   active data is in the target VLUN; and

12   second metadata to indicate when and to locate where second snapshot data of

13   the active data is in the target VLUN wherein the first metadata and the second

14   metadata indicate and locate a data element common to the first and second snapshot

15   data in the target VLUN, wherein the snapshot system preserves the active data of the

16   first snapshot while taking the second snapshot.

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18   7.   (Original) The snapshot system of claim 6, wherein the first metadata

19   includes a first log file pointer to locate the first snapshot data in the target VLUN and

20   the second metadata includes a second log file pointer to locate the second snapshot

21   data in the target VLUN.

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23   8.   (Original) The snapshot system of claim 6, wherein the first metadata

24   includes a first bitmap to indicate when the first snapshot data has migrated to the target

25   VLUN and a first log file to locate the first snapshot data in the target VLUN, and the

26   second metadata includes a second bitmap to indicate when the second snapshot data

27   has migrated to the target VLUN and a second log file to locate the second snapshot

28   data in the target VLUN.

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1 9. (Previously presented) The snapshot system of claim 6, wherein a first

2 bitmap and a second bitmap indicate that the first snapshot data and the second

3 snapshot data have migrated to the target VLUN.

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5 10. (Previously presented) The snapshot system of claim 6, wherein a first

6 log file and a second log file locate the first snapshot data and the second snapshot

7 data that have migrated to the target VLUN.

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9 11. (Previously presented) The snapshot system of claim 6, wherein the first

10 metadata and the second metadata indicate some of the first and second snapshot data

11 remain in the source VLUN.

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13 12. (Original) The snapshot system of claim 6, wherein the first metadata

14 indicates that the original data of the first snapshot is in the target VLUN and the second

15 metadata indicates that the original data of the second snapshot is in the source VLUN.

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17 13. (Previously presented) The snapshot system of claim 6, wherein a first

18 log file and a second log file each include a pointer identifying the address of the

19 common data element in the target VLUN.

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21 14. (Previously presented) A method of destaging data of one or more

22 snapshots to maintain data consistency of original data between a cache memory and a

23 target Virtual Logical Unit Number (VLUN) of a data storage system, comprising:

24 reading bitmaps for all of the snapshots into a first host memory;

25 reading log files for all of the snapshots into the first host memory;

26 searching the bitmaps to identify snapshots that require the original data to be

27 destaged;

28 destaging the original data to an available location in the target VLUN;

29 updating each log file associated with the identified bitmaps by adding pointers to

30 the original data located in the target VLUN; and

1   updating each associated bitmap to indicate completion of the destage operation

2   to the target VLUN.

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4   15.   (Original) The method of claim 14, further comprising searching the

5   bitmaps for the presence of original data in the target VLUN, determining the next

6   available target address for the next destage operation, checking the cache memory to

7   see if other original dirty data needs to be destaged to the target VLUN and if so,

8   identifying additional snapshots requiring original data to be destaged and if not, writing

9   updated bitmaps and log files to the target VLUN.

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11   16.   (Currently amended) The method of claim 14, further comprising writing

12   the log files and the bitmaps to the target VLUN, removing a dirty data designation for

13   the destaged original data still in the cache memory and sending a destage operation

14   complete status.

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16   17.   (Previously presented) A method of snapshot operation in a data storage

17   system in a first host that communicates with a cache memory, a source Virtual Logical

18   Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:

19   receiving requests from an application to modify data in the cache memory;

20   writing the modified data to the cache memory;

21   destaging the original data to the target VLUN to preserve the original data of a

22   first snapshot and a second snapshot; and

23   updating the first and second metadata to locate the original data common to the

24   first and second snapshot in the target VLUN.

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26   18.   (Original) The method of claim 17, further comprising destaging the first

27   and second metadata to the target VLUN.

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1   19.   (Original) The method of claim 17, further comprising updating the first

2   and second metadata to indicate the presence of the destaged original data in the target

3   VLUN.

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5   20.   (Original) The method of claim 19, further comprising destaging the first

6   and second metadata to the target VLUN.

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8   21.   (Original) The method of claim 17, further comprising destaging the

9   modified data in the cache memory to the source VLUN to maintain data consistency.

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11   22.   (Previously presented) A method of snapshot operation in a data storage

12   system in a first host that communicates with a cache memory, a source Virtual Logical

13   Unit Number (VLUN), a target VLUN, a plurality of bitmaps, and a plurality of log files,

14   comprising:

15   receiving requests from an application to modify data in the cache memory;

16   writing the modified data to the cache memory;

17   destaging the original data to the target VLUN to preserve the original data of a

18   first snapshot and a second snapshot;

19   adding a pointer in a first log file to locate the original data in the target VLUN;

20   updating a first bitmap to indicate the presence of the destaged original data in

21   the target VLUN;

22   adding a pointer to the original data in a second log file to locate the original data

23   in the target VLUN; and

24   updating a second bitmap to indicate the presence of the original data in the

25   target VLUN.

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27   23.   (Original) The method of claim 22, further comprising destaging the

28   modified data in the cache memory to the source VLUN to maintain consistency.

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30   24.   (Original) The method of claim 22, further comprising destaging the first

     and second bitmaps and the first and second log files to the target VLUN.

1   25.   (Currently amended) ~~A method of error recovery in a data storage system~~

2 ~~wherein a first host verifies that original data has or has not been destaged to a target~~

3 ~~Virtual Logical Unity Number (VLUN), comprising: (a)~~ The method of claim 14, wherein

4 the step of searching the bitmaps to identify snapshots that require the original data to

5 be destaged occurs after the data storage system fails and includes reading a bitmap,

6 wherein if the bitmaps contain a value in a bit position [representing] identifying the

7 original ~~dirty~~ data is dirty in cache memory, destaging the original data to the target

8 VLUN, and wherein if the bitmap contains an inverse value in the bit position

9 representing the presence of the original ~~dirty~~ data in the target VLUN, not destaging

10 the original data.

11   ~~(b) removing the dirty data designation for the destaged data; and~~

12   ~~(c) repeating the steps (a) and (b) until all of the original dirty data is destaged~~

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14   26.   (Previously presented) A method of snapshot operation for a data storage

15 system with a first host that communicates with a cache memory, a source Virtual

16 Logical Unit Number (VLUN) and a target VLUN, comprising:

17   generating first metadata to locate first snapshot data and to indicate when the

18 first snapshot data is in the target VLUN, wherein generating the first metadata includes

19 generating a first log file pointer to locate first snapshot data in the target VLUN; and

20   generating second metadata to locate second snapshot data and to indicate

21 when the second snapshot data is in the target VLUN, wherein the first and second

22 metadata locate the same data in the target VLUN, and wherein generating the first

23 metadata includes changing a first bitmap to indicate first snapshot data has migrated to

24 the target VLUN.

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26   27.   (Previously presented) A method of snapshot operation for a data storage

27 system with a first host that communicates with a cache memory, a source Virtual

28 Logical Unit Number (VLUN) and a target VLUN, comprising:

29   generating first metadata to locate first snapshot data and to indicate when the

30 first snapshot data is in the target VLUN; and

1   generating second metadata to locate second snapshot data and to indicate

2   when the second snapshot data is in the target VLUN, wherein the first and second

3   metadata locate the same data in the target VLUN, wherein generating the second

4   metadata includes generating a second log file pointer to locate second snapshot data

5   in the target VLUN, and wherein generating the second metadata includes changing a

6   second bitmap to indicate second snapshot data has migrated to the target VLUN.

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8   28.   (Previously presented) A snapshot system for a data storage system

9   including a first host that communicates with a cache memory, a source Virtual Logical

10   Unit Number (VLUN), a target VLUN, and metadata, comprising:

11   a source VLUN for active data;

12   a target VLUN to store migrated snapshot data;

13   first metadata to indicate when and to locate where the first snapshot data is in

14   the target VLUN, wherein the first metadata includes a first bitmap to indicate when the

15   first snapshot data has migrated to the target VLUN and a first log file to locate the first

16   snapshot data in the target VLUN; and

17   second metadata to indicate when and to locate where second snapshot data is

18   in the target VLUN, wherein the first metadata and the second metadata to indicate and

19   locate the same snapshot data in the target VLUN, and wherein the second metadata

20   includes a second bitmap to indicate when the second snapshot data has migrated to

21   the target VLUN and a second log file to locate the second snapshot data in the target

22   VLUN.

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24   29.   (Previously presented) A snapshot system for a data storage system

25   including a first host that communicates with a cache memory, a source Virtual Logical

26   Unit Number (VLUN), a target VLUN, and metadata, comprising:

27   a source VLUN for active data;

28   a target VLUN to store migrated snapshot data;

29   first metadata to indicate when and to locate where the first snapshot data is in

30   the target VLUN; and

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1 second metadata to indicate when and to locate where second snapshot data is

2 in the target VLUN wherein the first metadata and the second metadata to indicate and

3 locate the same snapshot data in the target VLUN, wherein the first metadata and the

4 second metadata indicate snapshot data remain in the source VLUN.

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6 30. (Previously presented) A method of snapshot operation in a data storage

7 system in a first host that communicates with a cache memory, a source Virtual Logical

8 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:

9   receiving requests from an application to modify data in the cache memory;

10   writing the modified data to the cache memory;

11   destaging the original data to the target VLUN to preserve the original data of a

12 first snapshot and a second snapshot;

13   updating the first and second metadata to locate the original data in the target

14 VLUN; and

15   destaging the first and second metadata to the target VLUN.

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17 31. (Previously presented) A method of snapshot operation in a data storage

18 system in a first host that communicates with a cache memory, a source Virtual Logical

19 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:

20   receiving requests from an application to modify data in the cache memory;

21   writing the modified data to the cache memory;

22   destaging the original data to the target VLUN to preserve the original data of a

23 first snapshot and a second snapshot;

24   updating the first and second metadata to locate the original data in the target

25 VLUN;

26   updating the first and second metadata to indicate the presence of the destaged

27 original data in the target VLUN; and

28   destaging the first and second metadata to the target VLUN.

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1   32.   (Previously presented) A method of snapshot operation in a data storage

2   system in a first host that communicates with a cache memory, a source Virtual Logical

3   Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:

4   receiving requests from an application to modify data in the cache memory;

5   writing the modified data to the cache memory;

6   destaging the original data to the target VLUN to preserve the original data of a

7   first snapshot and a second snapshot;

8   updating the first and second metadata to locate the original data in the target

9   VLUN; and

10   destaging the modified data in the cache memory to the source VLUN to

11   maintain data consistency.

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